

Spectrochemical Series

Weak Field (Low Δ_o) $\rightarrow$ $I^- < Br^- < Cl^- < F^- < OH^- < H_2O < NH_3 < en < NO_2^- < CN^- < CO \leftarrow$
Strong Field (High Δ_o)

Tetrahedral Complexes

In tetrahedral complexes, 4 ligands surround the metal. Splitting is reversed and smaller.

- Lower energy: e (dx^2-y^2 , dz^2)
- Higher energy: t₂ (d_{xy} , d_{yz} , d_{xz})

Square Planar Complexes

Commonly formed by d⁸ metal ions (e.g., Ni²⁺, Pd²⁺, Pt²⁺). Usually low spin and diamagnetic.

Color of Complexes

Color arises due to d-d transitions. Light absorbed corresponds to Δ_o and the complementary color is observed.

Magnetic Properties

Unpaired electrons $\rightarrow$ Paramagnetic.

No unpaired electrons $\rightarrow$ Diamagnetic.

Magnetic moment (μ) = $\sqrt{n(n+2)}$ BM, where n = number of unpaired electrons.

Limitations of CFT

- Assumes ionic bonding only.
- Cannot explain metal-ligand covalency.
- Does not explain π -back bonding.

Crystal Field Theory (CFT) - UG Level

Notes

Introduction

Crystal Field Theory (CFT) explains the effect of ligands on the energy of d-orbitals in transition metal complexes. It assumes purely ionic interaction between metal ion and ligands.

Important Terms

- **Ligands:** Species that donate electron pairs to the metal ion.
- **Coordination Number:** Number of ligand atoms bonded to the metal.
- **Complex Ion:** Metal ion with surrounding ligands.
- **Crystal Field Splitting:** Difference in energy between split d-orbitals.

d-Orbital Splitting in Octahedral Complex

In an octahedral complex, six ligands approach along x, y, and z axes. The d-orbitals split into two sets:

- Higher energy (eg): dx^2-y^2 , dz^2
- Lower energy (t_{2g}): dxy , dyz , dxz

The energy difference between these sets is Δ_0 (octahedral crystal field splitting energy).

High Spin and Low Spin Complexes

The value of Δ_0 depends on ligand strength.

If $\Delta_0 < \text{Pairing Energy}$ → electrons avoid pairing
→ High Spin Complex.

If $\Delta_0 > \text{Pairing Energy}$ → electrons pair → Low